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ABSTRACT

In this study, children's problem solving responses were compared to performance on the Matching Familiar Figures test (MFF). The MFF and two pattern matching tasks were administered in counterbalanced order to 94 children between 8 and 12 years old. The items for each pattern matching task had one standard and eight variants each composed of 8 black and white dots arranged in circles. In two stepwise multiple regression analyses (1) the MFF variables and age were used to predict each of the pattern matching (dependent) variables; and (2) the pattern matching variables, age, sex, and the order of test administration were used to predict MFF errors and latency. Results are tabulated and discussed. (SB)

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The Relationship of Some Problem Solving Variables to Cognitive Tempo

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Although the Matching Familiar Figures test (the MFF) has been used extensively in the past 10 years to predict both problem solving performance and personality variables, there have been three issues, raised recently, that attracted our attention. First, Block, Block, & Harrington (1974) asked whether MFF latency or MFF errors was a more important factor in predicting performance. Due to methodological, statistical, and interpretive difficulties with the previous MFF literature (see Ault, Mitchell, & Hartmann, 1976; Egeland & Weinberg, 1976), the issue of the relative importance of the MFF variables in predicting performance on problem solving tasks (rather than on personality) with elementary school children (rather than preschoolers) has not been adequately addressed.

The second factor that motivated our study was the work of Haskins and McKinney (1976). They used an MFF-like task, originally devised by Neimark and Lewis (1967). Called the Pattern Matching task, the items were composed of circles of dots instead of pictures of common objects. The dots on the standard were covered with removable shutters and a mean expected information score was derived from the amount of information revealed by each shutter opened on the standard. Haskins and McKinney found that MFF errors were more important predictors of mean information score and that MFF latency was unrelated to latency on the Pattern Matching task. The lack of validity for MFF latency contrasted strongly with previous studies (e.g., Kagan, 1965) and we had thought of several other dependent variables that could be derived from the Pattern Matching task which might be more sensitive indicators of a relationship between cognitive tempo and children's strategies of gathering and using information. So we believed that a replication and extension of Haskins and McKinney's work was warranted.

The third recent development underlying our study was the suggestion made by Zelniker (Note 1) that cognitive tempo could be related to various strategies of scanning the stimulus array. In particular, she proposed that some children may use a global scan in which an entire variant is viewed while other children might use a detailed scan, checking individual details across variants. By using a variation of Haskins and McKinney's task, in which the standard remained visible but each dot on each variant was covered with a removable sticker, we could obtain two measures of detailed versus global scanning. In addition, this pattern matching task with the variants covered provided additional measures of any relationship between cognitive tempo and the gathering and using of information. The new dependent variables we proposed for the Pattern Matching-Standard Covered task could also be used on the Pattern Matching-Variants Covered task.

The MFF and the two Pattern Matching tasks were administered in counterbalanced order to 94 children between 8 and 12 years old. The items for each pattern matching task had 1 standard and 8 variants, each composed of 8 black and white dots arranged in circles. In the Pattern Matching-Standard Covered task, the 8 dots on the standard were covered with removable stickers and all the variants remained visible. In the

Pattern Matching-Variants Covered task, all 64 dots of the variants were covered with stickers and the standard remained visible. The distribution of black or white dots was carefully prearranged so that at 4 positions (say the 3, 6, 9, and 12 o'clock position), on all variants the dot was white on four variants and the dot was black on the other four variants. In the remaining positions, the dot was white on just one variant and black on the other 7 variants. The mean expected information score would thus vary, depending on which dot position a child chose to reveal.

Table 1 lists all the dependent variables and their split-half reliabilities on each of the three tasks. The first two variables, total number of errors and mean latency, are the traditional MFF measures and were also used on the two pattern matching tasks. The last variable listed, mean expected information score, was the same measure Haskins and McKinney used on their Pattern Matching-Standard Covered task. In addition, we were particularly interested in how often children (a) offered a solution before they had uncovered sufficient information to guarantee being correct, (b) made irrelevant choices of information, (c) made redundant choices of information, and (d) offered an incorrect solution after they had enough information to avoid that mistake. We consider these to be measures of gathering and using information, and they were assessed on both pattern matching tasks. In addition, on the Pattern Matching-Variants Covered task, the children's patterns of removing stickers could be analyzed for two detailed scanning styles: (a) removing stickers from dots in the same position across variants, that is, removing the stickers from all the 3 o'clock positions before removing the stickers from all the 6 o'clock positions, and (b) removing stickers first from the positions on the variants that corresponded to the white dots on the standard.

For reasons outlined elsewhere (Ault et al., 1976), we conducted two basic sets of stepwise multiple regression analyses. In one set, the MFF variables and age were used to predict each of the pattern matching variables listed in Table 1, and in the other set, the pattern matching variables, age, sex of subject, and the order of test administration were used to predict MFF errors and MFF latency. A summary of these results can be found in Tables 2, 3, and 4.

As notes at the bottom of Table 2, multiple R equals .70, indicating that 49% of the variance in MFF errors can be explained. In Table 3, multiple R equals .77, indicating that nearly 60% of the variance in MFF latency can be explained. Two variables from the Pattern Matching-Standard Covered task emerged as significant predictors of both MFF errors and MFF latency. These are starred on the left column in both Tables 2 and 3; they are (a) responding before sufficient information was gathered to assure correct performance and (b) making errors even after sufficient information had been gathered. Increases in these two measures are found for children who make more errors and respond more quickly on the MFF.

The information gathering strategies of obtaining redundant or irrelevant information were not strongly related to MFF performance. Neither was the mean expected information score. As indicated toward the bottom of Table 4, only about 10% of the variance in mean expected information score can be predicted from the MFF (the 13% value includes age as a predictor). This

is quite similar to the 10% value obtained by Haskins and McKinney (1976). Other aspects of our study, however, disagree substantially with their results. From commonality analyses and a multitrait-multimethod matrix, our results suggest that MFF errors and MFF latency are often equally important as predictors of problem solving performance and that MFF latency does generalize to the tendency to respond quickly or slowly on other problem solving tasks. For example, the correlation between MFF latency and latency on the Pattern Matching-Standard Covered task was .55. Moreover, several measures of gathering and using information are related to cognitive tempo, particularly responding with insufficient information and making errors with sufficient information.

Age was an important predictor of problem solving performance. As children get older, they make fewer irrelevant responses on the Pattern Matching-Standard Covered task, gather more information with a response on the Pattern Matching-Standard Covered task, take longer on the Pattern Matching-Variants Covered task, and make fewer errors on the MFF. Surprisingly, latency on the MFF did not increase with age.

Finally, our results addressed Zelniker's (Note 1) suggestion that detailed versus global scanning strategies may be related to cognitive tempo. Responding first to the same dot position across the variants on the Pattern Matching-Variants Covered task was a significant positive predictor of latency on that task and on the MFF, indicating that as latency increased, the number of these detailed responses increased. The raw correlations, however, were low: $r = .16$ between the detailed scanning strategy and MFF latency, and $r = .30$ between the strategy and latency on the Pattern Matching-Variants Covered task. The other variable we thought might reflect a detailed scanning strategy was responding first to the positions on the variants that corresponded to the white dots on the standard. This was not related to either MFF variable. Thus, while our support of Zelniker's hypothesis is limited, there is some evidence to warrant further investigations along this line.

Reference Notes

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Table 1

Dependent Variables and Their Split-half Reliabilities for All Measures

Variable	Task		
	MFF	PM-ST*	PM-VC*
Total number of errors	.643	.655	.622
Total latency to the first guess	.969	.866	.810
Mean latency per sticker removed before the first guess		.902	.745
Total number of stickers removed		.928	.769
Total number of responses with insufficient information to locate the answer		.722	.909
Total number of irrelevant responses[a]		.566	.926
Total number of redundant responses[b]		.812	.471
Total number of errors with sufficient information not to make that error		.128	.172
Total number of responses to the same dot position across variants before removing more stickers from one variant[c]			.858
Total number of responses to white dot positions on the standard before responses to black dot positions[c]			.692
Mean expected information scores		.707	

[a]Irrelevant responses are the number of stickers removed from dots which provide no new information before enough information is available to solve the item.

[b]Redundant responses are the number of stickers removed after sufficient information is available to solve the item.

[c]This is a measure of a detailed rather than a global scan.

*PM-ST = Pattern Matching-Standard Covered; PM-VC = Pattern Matching-Variants Covered.

Table 2

Regression Equation Predicting MFF Errors

from Pattern Matching Variables

Predictors	β	F(1, 78) for β	p
* Responses with insufficient information PM-ST	.811	13.637	<.01
Total stickers removed PM-ST	.033	.029	n.s.
Age	-.180	3.811	<.06
* Errors with sufficient information PM-ST	.316	7.632	<.01
Errors PM-ST	-.310	2.249	n.s.
Irrelevant responses PM-ST	.058	.196	n.s.
Errors with sufficient information PM-VC	.070	.440	n.s.
Responses with insufficient information PM-VC	-.288	2.650	n.s.
Errors PM-VC	.217	.948	n.s.
Responses to the same dot position first PM-VC	-.108	1.449	n.s.
Error-latency interaction PM-VC	.059	.127	n.s.
Latency per sticker PM-ST	-.612	2.907	n.s.
Latency PM-ST	.578	2.525	n.s.

Note. $R = .700$; $R^2 = .490$; $F(13, 78) = 5.755$, $p < .01$.

Table 3

Regression Equation Predicting MFF Latency

from Pattern Matching Variables

Predictors	β	F(1, 78) for β	p
Latency PM-ST	-.140	.285	n.s.
Error-Latency interaction PM-ST	-.679	18.177	<.01
Latency per sticker PM-ST	.971	18.314	<.01
* Responses with insufficient information PM-ST	-.496	8.161	<.01
Errors PM-ST	.632	8.827	<.01
Responses to the same dot position first PM-VC	.262	9.034	<.01
* Errors with sufficient information PM-ST	-.223	4.473	<.05
Responses to white dot positions first PM-VC	-.154	3.532	n.s.
Redundant responses PM-VC	.125	1.255	n.s.
Latency PM-VC	-.659	7.604	<.01
Errors PM-VC	-.188	3.202	n.s.
Latency per sticker PM-VC	.321	4.709	<.05
Total stickers PM-VC	.403	2.768	n.s.

Note. $R = .773$; $R^2 = .598$; $F(13, 78) = 8.920$, $p < .01$.

Table 4

Summary of the Significant Regression Equations

Predicting the Pattern Matching Variables

from MFF Variables and Age

Dependent variable	R^2	Significant predictors
Errors PM-ST	.2000**	MFF errors
Latency PM-ST	.3380**	MFF latency
Latency per sticker PM-ST	.3470**	MFF latency and MFF errors
Irrelevant responses PM-ST	.1190*	Age
Responses with insufficient information PM-ST	.2516**	MFF errors
Errors with sufficient information PM-ST	.1622**	MFF errors
Mean expected information score PM-ST	.127*	Age, MFF latency, and MFF errors
Latency PM-VC	.1450**	Age

*$p < .05$

**$p < .01$